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REACTOR OPERATIONS AND RADIOACTIVE WASTES OPERATIONS QUARTERLY REPORT

OCTOBER–DECEMBER 1959

NOTICE

OAK RIDGE NATIONAL LABORATORY
operated by
UNION CARBIDE CORPORATION
for the
U.S. ATOMIC ENERGY COMMISSION

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REACTOR OPERATIONS

AND RADIOACTIVE WASTES OPERATIONS

QUARTERLY REPORT

October - December, 1959

By

J. A. Cox

Prepared from reports by:

F. T. Binford
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MAR 16 1960

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee
operated by
UNION CARBIDE CORPORATION
for the
U. S. ATOMIC ENERGY COMMISSION

CONTENTS

REACTOR OPERATIONS
AND RADIOACTIVE WASTES OPERATIONS
QUARTERLY REPORT

Summary

About 500 curies of fission products were released late in October from the Hot Pilot Plant into the process waste system. This was mostly contained in the Waste Treatment Plant or in the Storage Pond by a series of improvised procedures. A release of about 3 curies of radioactive ruthenium from the 3039 stack occurred during maintenance operations. This required considerable cleaning of streets. A release of plutonium-contaminated dust due to an explosion in the Hot Pilot Plant occurred on November 20, 1959. The contaminated dust was sucked into the Graphite Reactor which was shut down from November 21 to December 22 while the building was being cleaned. Operations are again routine.

Waste Pit No. 4 began leaking Ru^{106} into White Oak Creek late in the quarter, and this caused a slight increase in the percentage of maximum permissible concentration of radioactivity in the river. The leakage was intercepted in sumps and pumped back to the pits. In spite of these incidents, the Clinch River had the lowest percentage of MPC of any quarter in 1959.

The ORR was operated routinely during the quarter. Work is beginning on installation of the 30 Mw of additional cooling capacity.

1. OAK RIDGE RESEARCH REACTOR

1.1. Operations

W. R. Casto

Operations

The ORR was operated at a power level of 16 Mw through cycle 16 which terminated October 4. During the remaining portion of this quarter, the operating level was 20 Mw except for a special test run at 30 Mw. The test run was performed on November 27 and 28 to check the operability of the system at this power. Results of the test indicate temperature, radiation, and activity levels are within the range anticipated.

Total operating time for the quarter was 1597.901 hours.

The operating data for the ORR are given in Table 1.1.

TABLE 1.1. ORR OPERATIONS

Period October 1, 1959, through December 31, 1959

	This Quarter	This Quarter	Year to Date
Total energy, Mwd	1264.7	1195.1	5036.4
Average power, Mw operating hour	19.0	16.1	18.3
Time operating, %	72.4	80.8	75.4
Reactor water radioactivity, c/m/ml (av)	23,855	24,330	26,727
Pool water radioactivity, c/m/ml (av)	382	433	520
Reactor water resistivity, ohm-cm	728,231	780,666	792,224
Pool water resistivity, ohm-cm (av)	768,045	901,600	868,661
Research samples	7	14	53
Radioisotope samples	97	129	385

The core configuration at the end of this quarter is indicated in Figure 1.1.

Cycles of operation during this period are shown in Table 1.2.

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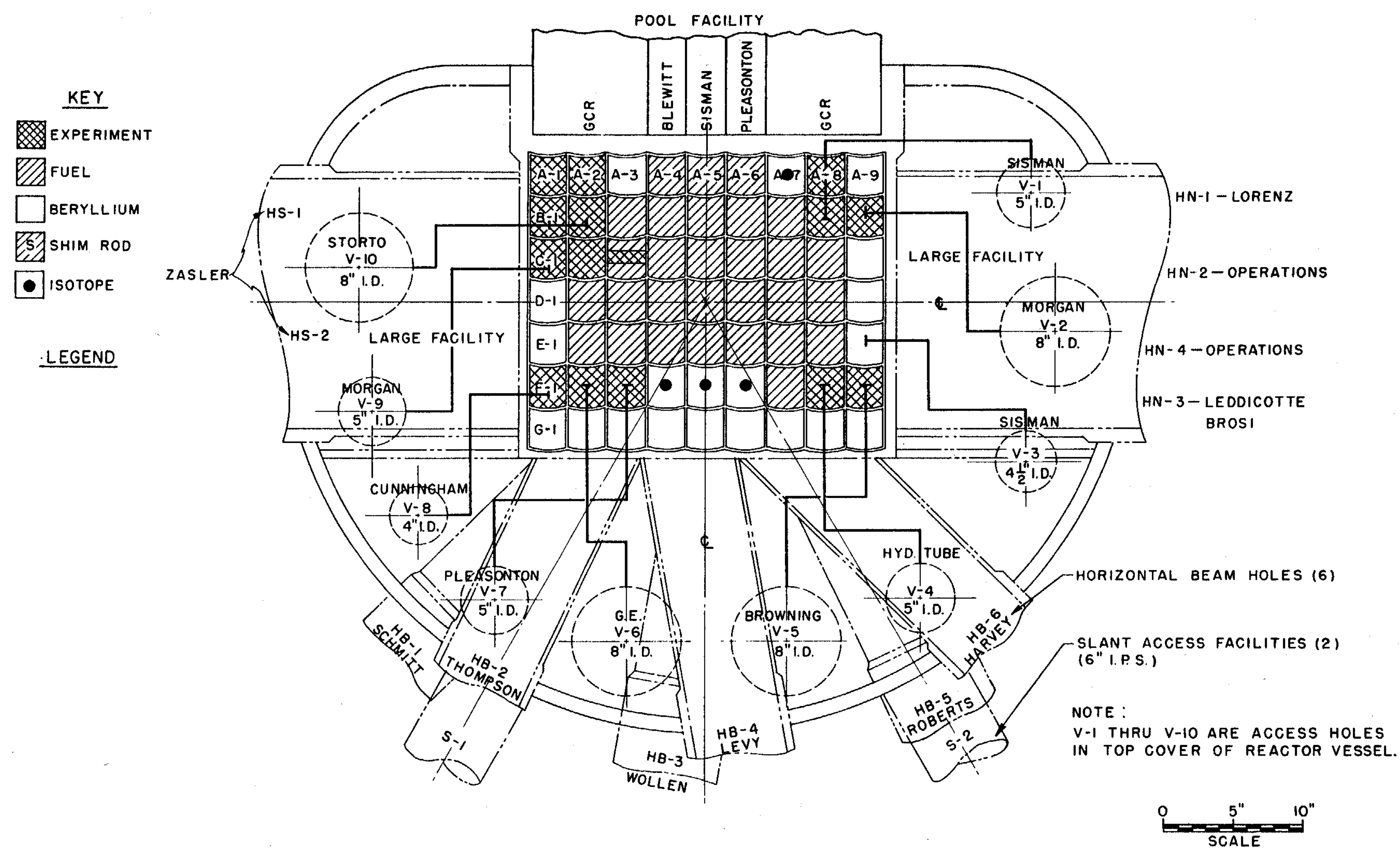

FIGURE 1.1

RESEARCH ASSIGNMENTS &
FUEL LOADING ON 9-30-59

C-33561

TABLE 1.2. CYCLES OF OPERATION

Cycle No.	Date Begun	Date Ended	Accumulated Energy (Mwd)
16	In Progress	October 4	38.4
17	October 9	October 31	422.4
18	November 5	November 28	396.8
19	December 3	December 27	407.1

Figures 1.2, 1.3, 1.4, and 1.5 indicate shim rod positions versus the operating time during cycles 16, 17, 18, and 19, respectively.

Shutdowns

Four major shutdowns occurred during this quarter.

October 4 through October 9. Modifications of the HB-hole plugs were completed. "In-pool" installation work on major experiments was performed. Reactivity worth experiments were conducted.

October 31 through November 5. The GCR capsules were removed and transferred to the hot cell without incident. "In-pool" installation work for GCR capsule experiment #2 was performed. Major maintenance on the off-gas system was performed.

November 28 through December 3. A rupture of a sample in the B-9 experiment required the installation of lead shielding on the B-9 piping in the reactor pool. The installation of a new access thimble in the north pool wall was completed. Dummy samples were installed in the MSR loop and the experiment was readied for operation at full temperature and pressure.

December 27 through December 31 (still in progress). A major revision to the building off-gas system to eliminate the possibility of water plugging was completed. Revisions to the hydraulic tube system were completed to permit the irradiation of enriched fissionable materials.

Table 1.3 lists the unscheduled shutdowns which occurred this quarter.

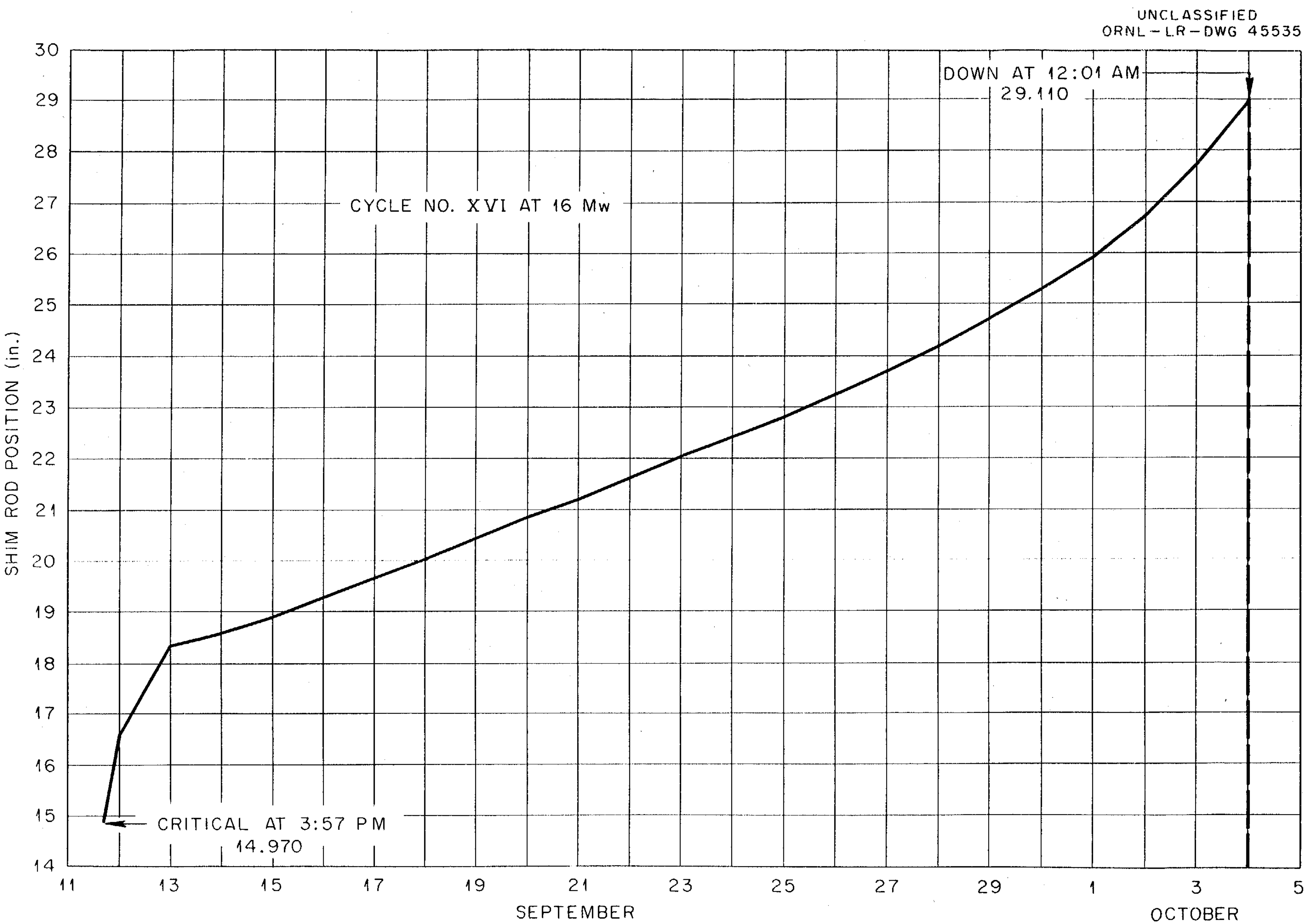

Fig. 1. 2. Shim Rod Position vs Time and Cycle.

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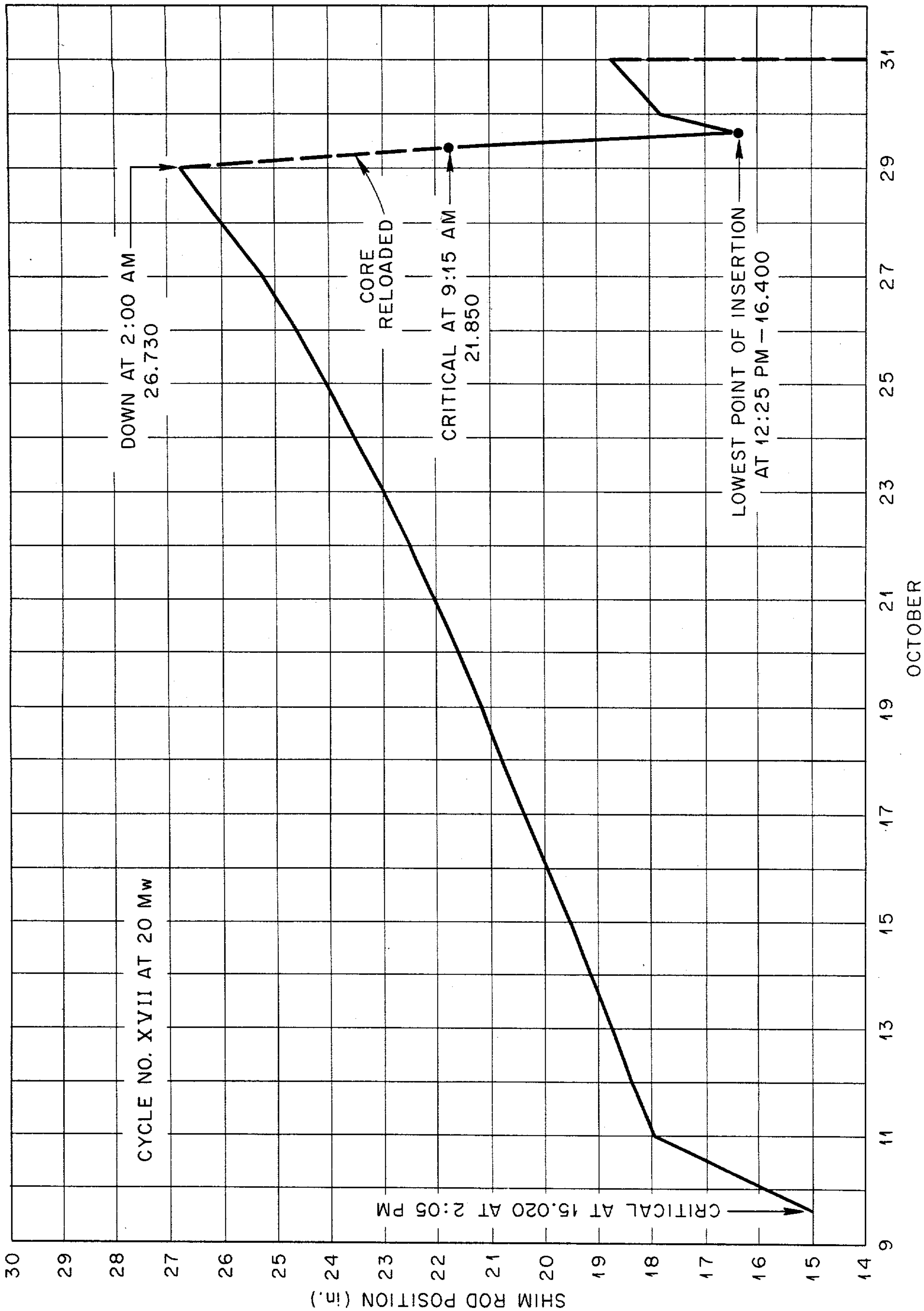

Fig. 1.3. Shim Rod Position vs Time and Cycle.

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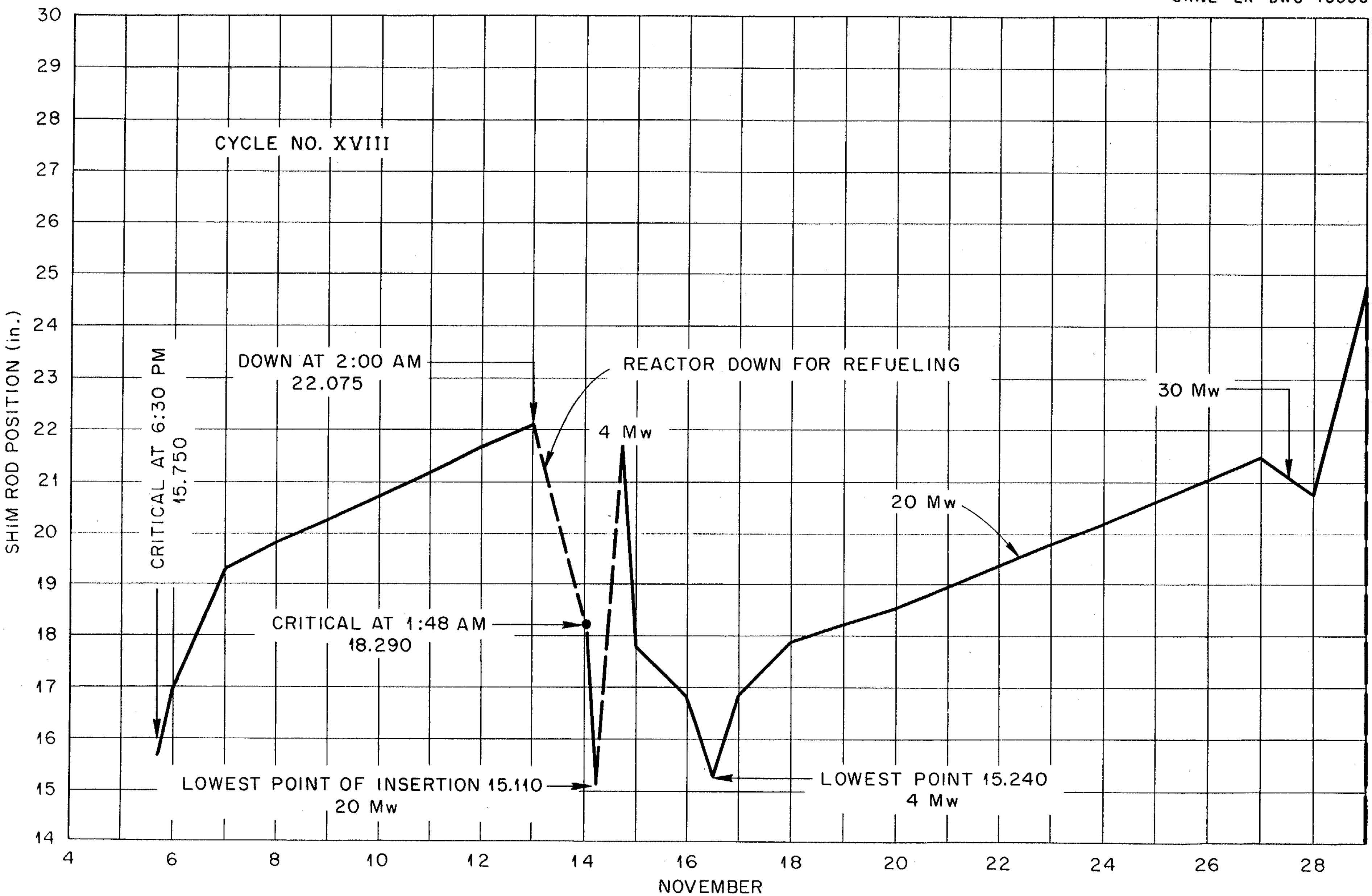

Fig. 1.4. Shim Rod Position vs Time and Cycle.

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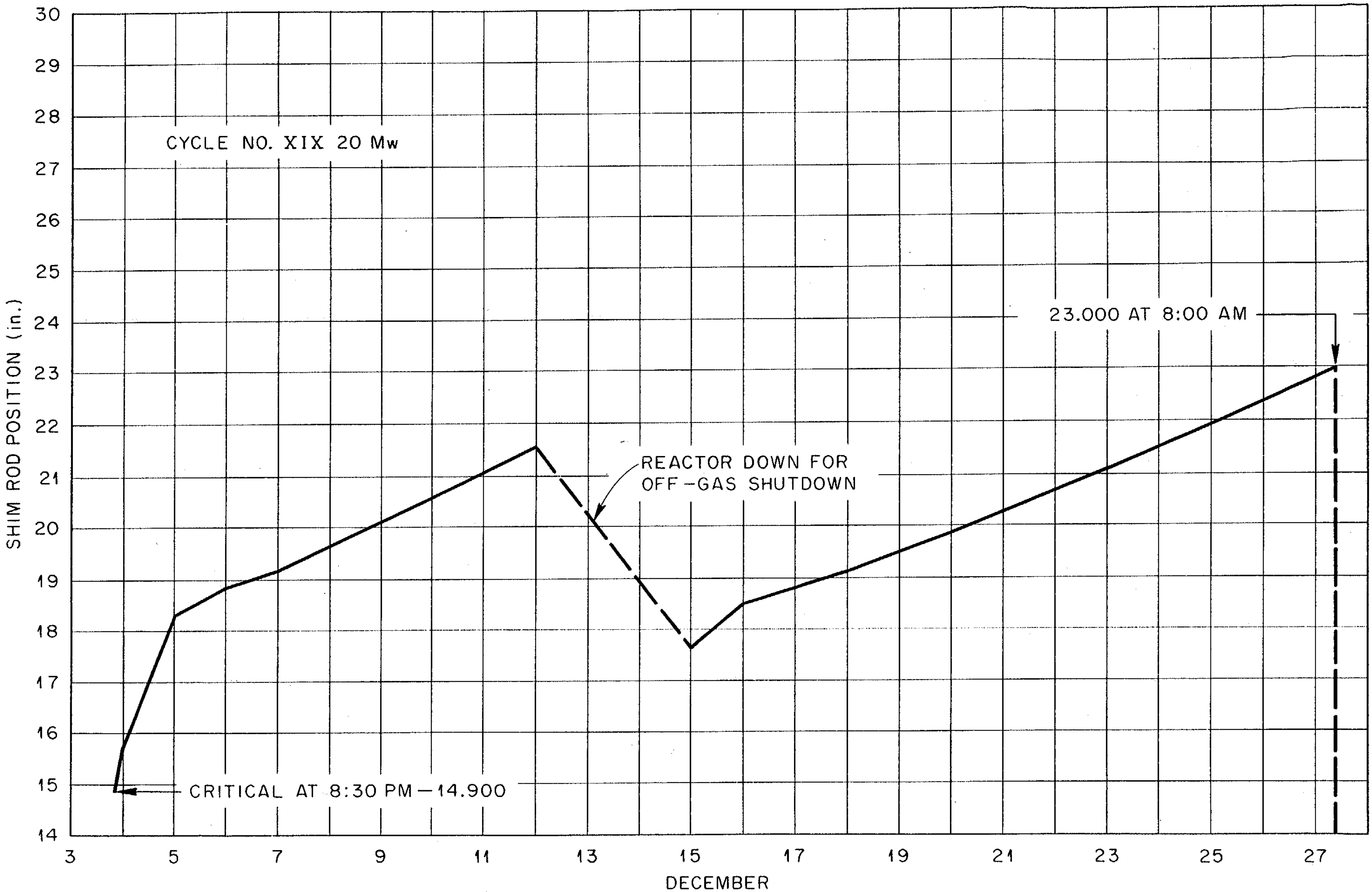


Fig. 1.5. Shim Rod Position vs Time and Cycle.

TABLE 1.3. UNSCHEDULED SHUTDOWNS AT THE ORR

Date	Duration (hr)	Remarks
10-13-59	0.250	Dropped #6 shim rod, reason unknown.
10-14-59	0.050	No. 2 safety recorder drove upscale giving a reverse; faulty instrument.
10-21-59	0.167	During revalving of the pool demineralizer, a reduction in pool cooling flow resulted in placing the reactor controls in the "start" mode thereby giving a $3N_L$ reverse.

Table 1.4 gives the analysis of the causes of shutdowns for this quarter.

TABLE 1.4. ANALYSIS OF ORR SHUTDOWNS

Description	Number	Down Time (hr)
Scheduled Shutdowns		
Regular, end of cycle	4	494.699
Regular, midcycle	2	14.734
Major repair of off-gas system	2	76.199
Subtotal	8	585.632
Unscheduled Shutdowns		
Instrument failure, reactor controls	2	0.300
Human error	1	0.167
Subtotal	3	0.467
TOTAL	11	586.099

Reactor Controls

A servo limit switch assembly for the ORR has been designed and installed in the ORR control room. The new assembly permits adjustments of the span to compensate for the changes in reactivity worth of the servo control rod and minimizes the work involved in changing the servo control from one shim rod to another.

A list of the major troubles encountered in the reactor controls system is given in Table 1.5.

TABLE 1.5. MALFUNCTION OF REACTOR CONTROLS

Item	Description
No. 6 drive tube	The drive failed. Inspection indicated a broken push rod. The drive was replaced.
No. 6A magnet	The magnet was shorted to ground. It was replaced.
No. 3 safety chamber	The chamber circuit failed due to condensation formation on the connector. The chamber was replaced.
Spare PCP chamber	This chamber was found defective with condensation on the connector. The chamber was removed for repair.
Fission chamber	The CRM channel became defective. The chamber was removed and inspection indicated that the insulating paper around the chamber had deteriorated, grounding the chamber. A new chamber was installed.

As a result of the failure in the chamber circuits, a routine replacement of each unit on a yearly basis is being established. All control chambers, excluding the fission chamber and the gamma chambers, have been in service since March 1958.

Minor revisions are being made on the push rods of the control drive units in an effort to reduce failures. A study of the drive-tube mechanism is being made in order to reduce the time required for installation and removal.

TABLE 1.6. ORR FACILITY ASSIGNMENT

Facility	Access Flange	Nature of Experiment	Division Sponsor
A-1, A-2	V-1	Pressurized water loop	Reactor Projects
A-8, C-2		UO_2-ThO_2 capsule irradiations	Chemical Technology
B-1, B-2	V-10	Gas-cooled loop	Reactor Projects (GE)
B-8, E-9	V-1, V-3	Irradiation damage studies	Solid State
B-9	V-2	Gas-cooled loop	Solid State
C-1	V-9	Fuel tests	Solid State
C-3		Irradiation damage studies	Solid State
F-1	V-8	Solid fuel studies	Metallurgy
F-2	V-6	Fuel tests	Reactor Projects (GE)

TABLE 1.6. (continued)

Facility	Access Flange	Nature of Experiment	Division Sponsor
F-3	V-7	Ne^{23}	Physics
F-4, F-5, F-6, A-7		Radioisotope production	Isotopes
F-8		Hydraulic rabbit	Operations
F-9	V-5	Fused-salt loop	Reactor Chemistry
P-1, 2, 3, 7, 8, and 9		EGCR capsule irradiations	Reactor Projects
P-4		Radiation damage	Solid State
P-5		Radiation damage	Solid State
P-6		He^{6}	Physics
HN-1		Homogeneous fuel loop	REED
HN-3		Pneumatic rabbit for activation analysis	Chemistry-Analytical Chemistry
HB-1		Magnetic analysis of fission fragments	Physics
HB-2		Neutron spectrometer	Solid State
HB-3		Neutron spectrometer	Physics
HB-4		Neutron spectrometer	Chemistry
HB-5		Neutron spectrometer	Physics
HB-6		Time-of-flight spectrometer	Physics
HN-2, HN-4			Operations
HS-1, HS-2			Operations

1.2. Be-Cd and Al-Cd Shim Rods for the ORR

C. D. Cagle

Design has been completed and a fabrication work order has been submitted for two Be-Cd and one Al-Cd shim rods for the ORR.

The Be-Cd rods will be installed in core positions F-4 and F-6. Their presence will increase the shutdown negative reactivity sufficiently to allow loading enough fuel to last for a complete three-week operating cycle.

The Al-Cd rod will be used to determine whether a fuel section is really necessary in shim rods. The measurements which will be made with this rod include:

1. Flux measurements in adjacent elements to detect any tendency toward flux peaking due to the absence of fuel in the rod.
2. Reactivity worth of the rod versus a new rod containing a fuel section.
3. Reactivity worth of the rod versus depleted rods.

1.3. Heat Transfer in the ORR Core at Elevated Power

J. F. Wett

The core of cycle 6 was analyzed and extrapolated to a power of 45 Mw. Investigation showed that the highest temperatures occurred at a point 17 inches below the top of the fuel plate in position D-3 and at the top of the fuel section of the shim rod in position D-6. Hot-spot and hot-channel factors were deduced from prior work and used in this analysis.

The results of this analysis indicate that the ORR fuel elements may be run at 45 Mw with inlet temperatures of 120°F and reactor flows of 18,000 gpm without danger of nucleate boiling. It further indicates that shim rods (especially new ones) might cause nucleate boiling under the same condition.

A full report of this analysis is contained in ORNL CF-59-9-68.

1.4. Training of Maritime Personnel

J. F. Wett

During the quarter, the division has been engaged in training a group of nine men as reactor supervisors. This is being provided in co-operation with the Maritime Commission in connection with the N.S. Savannah program. Training of this group will be terminated on January 15, 1960.

1.5. Fuel Element Temperatures in Stagnant Air

J. F. Wett

During the period July - October, 1959, an investigation to determine the relation between maximum surface temperature of an irradiated ORR fuel element suspended vertically in stagnant air and the irradiation history of the element was performed. This investigation led to the following semiempirical formula.

$$\theta \left[0.0064\theta^{0.72} + 0.5\right] = 1.37 \times 10^{3} \left[t^{-0.2} - (T + t)^{-0.2}\right] \frac{\bar{\phi}_i W_i P}{\bar{\phi}_c W_c}$$

$\theta = t_m - t_a$

t_m = maximum surface temperature of the element (°F)

t_a = ambient air temperature (°F)

t = decay time in seconds

T = irradiation time in seconds

$\bar{\phi}_i$ = average thermal flux in the element in question

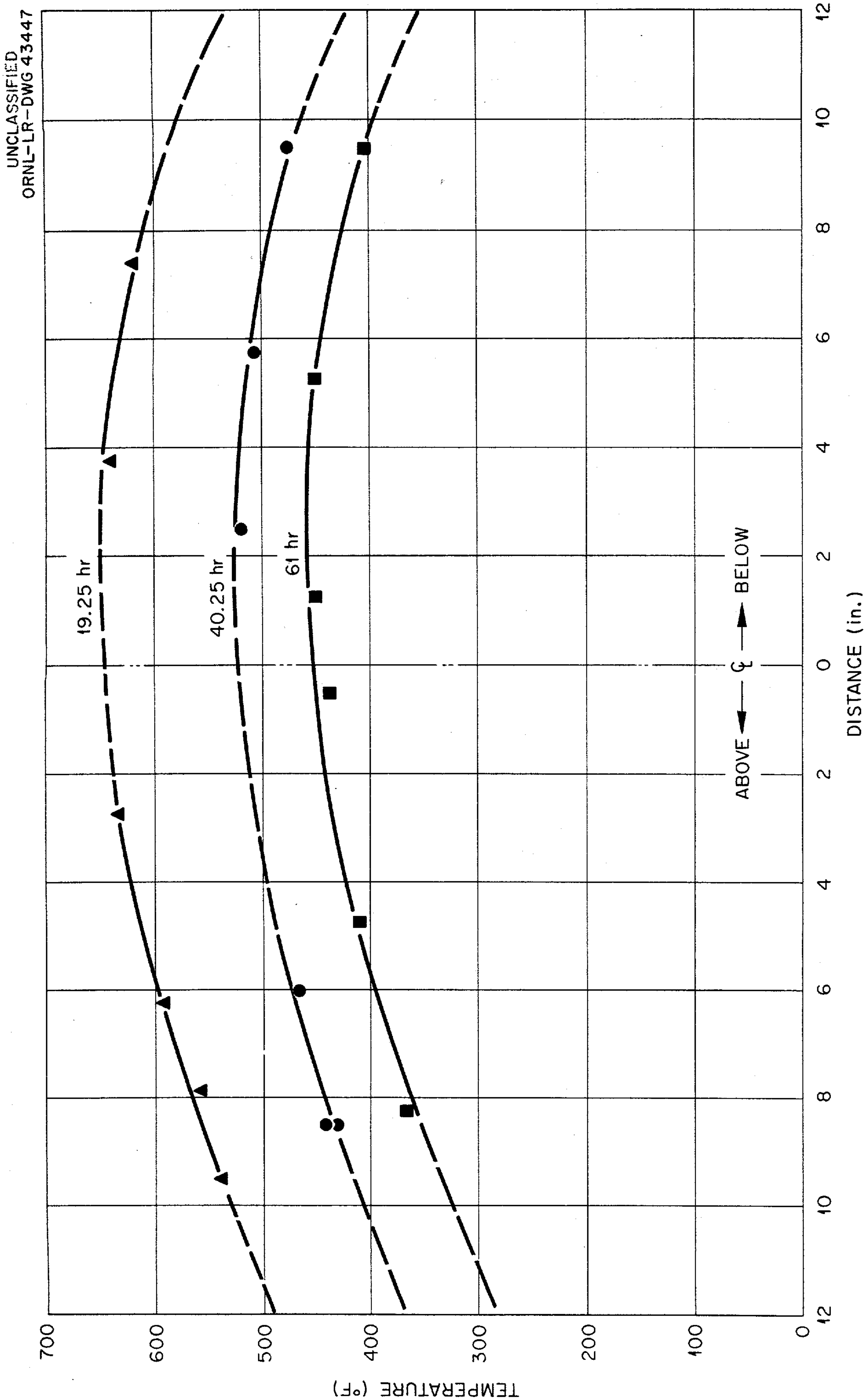
W_i = weight of U^{235} in the element in question (gm)

$\bar{\phi}_c$ = average thermal flux in the core

W_c = weight of U^{235} in the core (gm)

P = power of the reactor (Mw)

Figure 1.6 shows some typical temperature traverses, and Figure 1.7 shows a typical temperature transient. A complete report on this work is contained in ORNL 2892.


UNCLASSIFIED
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19.25 hr
40.25 hr
61 hr
ABOVE
BELOW
DISTANCE (in.)
TEMPERATURE (°F)
0
100
200
300
400
500
600
700
12
10
8
6
4
2
0
2
4
6
8
10
12

FIGURE 1.6

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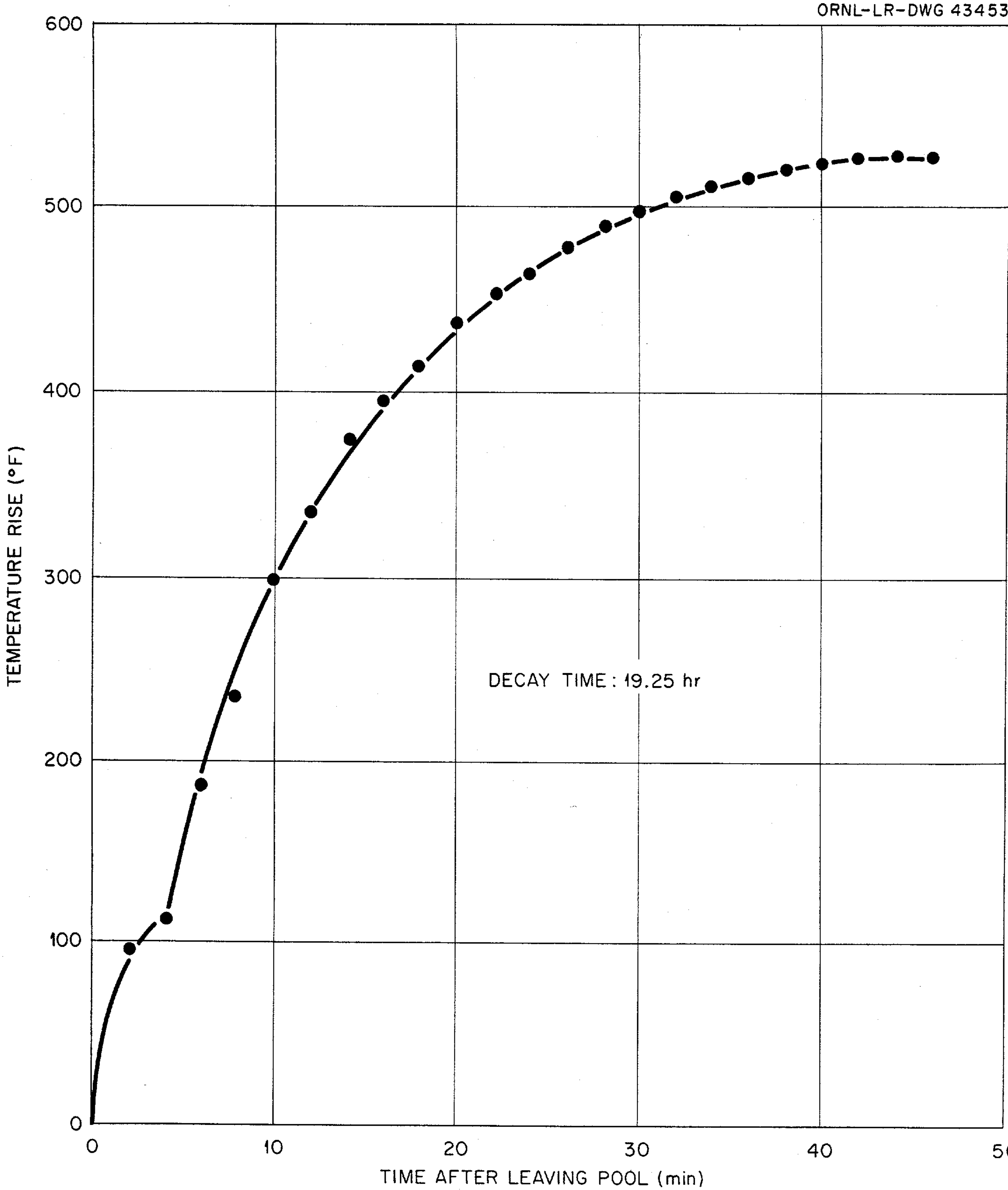

FIGURE 1.7

1.6. Radioactive Gases Discharged to the Off Gas by the ORR Degasifier

E. N. Cramer

An analysis procedure is being developed to use the 200-channel gamma spectrometer to identify the species and quantities of the radioactive gases discharged from the ORR degasifier to the off-gas system. Measurements are to be made on a routine basis, as required, to detect any damaged fuel element that might be in the core.

Work is proceeding in the following:

1. Better determination of half-lives.
2. Resolution of multiple components.
3. Evaluation of sampling techniques.
4. Evaluation of radioactivities trapped in the condensate from the off gas.
5. Formulation of procedures to be used by the shift engineers.
6. Analysis of the nonradioactive constituents of the gas.

A typical analysis is shown in Table 1.7.

TABLE 1.7. RADIOISOTOPES IN ORR OFF GAS

Gamma Energy Peak (Mev)	$T_{1/2}$ Obs.	Probable Radioisotope	$T_{1/2}$	Millicuries/hr*
0.0275	5.7 days	Cs^{133} (Xe^{133})	5.3 days	1.71
0.08	6.2 days	Xe^{133}	5.3 days	1.44
0.15	~1 hr			28.3[a]
	~3.35 hr	Kr^{85m}	4.4 hr	
	~8.65 hr	Xe^{135}	9.13 hr	
0.2	~1.6 - 2 hr (?)			29.8[a]
	~2.5 hr (?)	Kr^{88}	2.8 hr	
	8.8 hr			
0.25	~12 min			70.0[a]

*Degasifier flow at a chosen (.75)1.9 l/min and using analysis data at 10 minutes after sampling time (to allow for transmission time and some dispersion time).

[a] No attempt can be made in this sample to assign an amount to a particular isotope of possible ones listed.

? Not observed in this sample, but ordinarily present.

TABLE 1.7. (continued)

Gamma Energy Peak (Mev)	$T_{1/2}$	Probable Radioisotope	$T_{1/2}$	Millicuries/hr*
	~2 hr			
	9.3 hr	Xe^{135}	9.13 hr	
0.4	1.25 hr	Kr^{87}	1.3 hr	30.55[(a)]
	~4.75 hr			
0.5	18 - 27 min	Xe^{135}	16 min	0.70
0.625	2 hr			1.14[(a)]
	~9 hr	Xe^{135}	9.13 hr	
0.85	2.6 hr	Kr^{88}	2.8 hr	1.91
0.9	2.55 hr	Rb^{88} (Kr^{88})	2.8 hr (Kr^{88})	<1.0
1.0	1.1 hr			1.89[(a),(b)]
1.15				?
1.3	~1.8 hr	A^{41}	1.8 hr	85.2
1.45				?
1.5	2.5 - 3.3 hr	Kr^{88}	2.8 hr	3.25
1.71	~45 min			0.9[(a)]
1.81	2.9 hr	Kr^{88}	2.8 hr	0.9
2.0				1 - 10[(a)]
2.2	2.5 hr	Kr^{88}	2.8 hr	1 - 10[(a)]
2.4	3.5 hr	Kr^{88}	2.8 hr	1 - 10[(a)]
2.6				1 - 10[(a)]

[(b)] Mostly compton scatter edge from A^{41}.

?. Not observed in this sample, but ordinarily present.

1.7. Flux Noise Spectrum Measurements

A. L. Colomb

It has been shown[1] that flux noise spectrum measurements on a delayed critical reactor at zero power are equivalent to zero power transfer function amplitude measurements. The informatinn that can be obtained from the measure of the flux noise spectrum are the ratio of the neutron lifetime to the effective fraction of delayed neutrons, the negative reactivity in a subcritical system, and some approximation for power feedbacks.

The main advantage of the method lies in the fact that no complicated instruments are required. Only an ionization chamber must be installed close to the reactor core.

Preliminary measurements will start at the PCA facility at the beginning of March.

The ultimate goal of this experiment is to measure the neutron lifetime of the ORR reactor, to calibrate the ORR control rods, and to examine the high power feedbacks.

[1] M. N. Moore, Nuclear Science and Engineering. 3, 387-394 (1958).

2. ORNL GRAPHITE REACTOR

2.1. Operations

W. R. Casto

Operations

The operating data for the ORNL Graphite Reactor are given in Table 2.1.

TABLE 2.1. GRAPHITE REACTOR OPERATIONS

Period October 1, 1959, through December 31, 1959

	This Quarter	Last Quarter	Year to Date
Total energy, Mwd	187.8	280.9	1024.8
Average power, kw/operating hour	3406	3419	3421
Time operating, %	59.9	89.2	82.1
Exit air filters, Δp, in. H_2O (av)	3.38	3.42	3.67
Canal water radioactivity, c/m/ml (av)	1041	715	878
Research samples	126	287	969
Radioisotope samples	80	218	1000

Alpha Contamination

On November 20, at approximately 11:00 p.m., the Graphite Reactor building was extensively contaminated with plutonium from an accident at the Hot Pilot Plant in Building 3019. Contaminated dust was drawn into the building on the south and east sides. It permeated every laboratory and work area in the building and resulted in a prolonged reactor shutdown starting at 5:30 a.m., November 21, 1959. The shutdown lasted until 10:03 p.m., December 22, 1959, and was the longest time the reactor had been down (736.467 hours) in almost 17 years of operation.

During this month of down time the main building was cleaned by use of a vacuum system connected to the scanner holes and exit duct of the reactor. In general, the vacuum method was sufficient to clean the ceiling and walls to a point where health physics tolerances would permit painting. Some wall areas and practically all equipment had to be washed with rags and a special cleaning solution. The ceiling and walls were cleaned until smear results averaged not more than 30 d/m. A maximum single smear result of more than 300 d/m was not acceptable. For an area to be declared clean without painting, the smear results had to be a factor of 10 lower than those for painting. The floors were cleaned to the lower tolerance and then sealed with a concrete sealer. It was necessary to use a steel bristle brush on a rotary scrubbing machine in order to remove the paint spray and thus expose the floor for a complete health physics check.

After the main building and control room were declared clean, the decontamination of laboratories and rooms was started. At the end of the year the following additional areas were cleaned; conference room, men's rest room, and Lid Tank control room.

Drilling New Experiment Holes

A second hole was drilled in the top of the reactor. The drilling was started on August 10, 1959, and completed on September 19, 1959. This is a stepped hole through the concrete shield 8-in. diameter for the first four feet and 6-in. diameter through the remaining three feet. In the graphite the hole was drilled to a depth of 15 ft, with a diameter of 3 15/16 in. The position of the hole is one foot south of the east-west center line and 4 ft 2 in. west of the north-south center line. This hole is being used to give an additional facility for radiation studies at low temperatures.

Slug Ruptures

Slug rupture data are given in Table 2.2.

TABLE 2.2 SLUG RUPTURES

Rupture Number	Date	Row No.	Number From West End of Row	Lot	Remarks
274	10-7-59	1464	15 19	154	Indicated by probe
275	10-12-59	1865	17	112	Indicated by probe
276	10-26-59	0864	8	6141	Found by visual inspection
277	10-26-59	1071	16	6134	Found by visual inspection
278	11-2-59	2751	26	132	Found by visual inspection
279	11-5-59	2774	Unknown	110	Indicated by probe

New Exhaust Line in Exit-Air Duct

On December 8 work was begun on the installation of a 24-in. duct from the Hot Pilot Plant (Building 3019) into the exit-air duct between the Graphite Reactor and the filter house. The duct was completed on December 22 and put into operation immediately. All Hot Pilot Plant off gas and cell ventilation now goes to the Graphite Reactor stack. The cell ventilation air is filtered by the Pilot Plant filter house before delivery into the reactor exit-air duct. All other waste gases from the Pilot Plant are filtered by the reactor filter system only.

This operation is temporary and was set up so that repair could be made to the Hot Pilot Plant cell-ventilation and off-gas system. Approximately 18,000 cfm of ventilation air are being discharged into the Graphite Reactor stack. Thus far there has been sufficient cooling to permit the Graphite Reactor to operate at its normal power level; 3.5 Mw.

Facility Employment

An outline of the usage of the reactor is given in Table 2.3.

TABLE 2.3. GRAPHITE REACTOR FACILITY EMPLOYMENT

Facility	Nature of Experiment	Division Sponsor
3		Operations
4	Service irradiation facility	Isotopes
10	Water-cooled irradiation facility	Isotopes & Research
11		Operations
12	Cryostat	Solid State
13		Operations
14	Unit irradiation facility	Isotopes
15	Electrical component testing	Reactor Projects (GE)
16	Graphite thermocouple (annealing)	Operations
17-S		Operations
17-N		Operations
18	Service irradiation facility	Operations
19	Hydraulic rabbit tube	Solid State
20	Electrical component testing	Reactor Projects (GE)
21	Service irradiation facility	Operations
22	Pneumatic tube	Isotopes & Chemistry
30		Solid State
38-S		Reactor Projects (GE)
50-S	Neutron spectrometer	Physics
50-N	Cryostat	Solid State

TABLE 2.3 (continued)

Facility	Nature of Experiment	Division Sponsor
51-S	Neutron spectrometer	Physics
51-N	Enriched converter	Solid State
52-S	Neutron collimator	Physics
52-N	Cryostat	Solid State
53-N	Graphite temperature thermocouple	Operations
54-N		Operations
55-N		Operations
56-N	Fast pneumatic tube	Operations
56-S	Oscillator	Reactor Projects (GE)
57-N	Neutron beam collimator	ORSORT
57-S		Operations
58-N		Operations
58-S	Neutron beam collimator	Chemistry
59-S	Neutron beam collimator	Physics
60	Electric component testing	Reactor Projects (GE)
61	Electric component testing	Reactor Projects (GE)
A	Sample irradiation facility	Solid State
B	Sample irradiation facility	Isotopes
C	Sample irradiation facility	Operations
D	Sample irradiation facility	Operations
1768	Sample irradiation facility	Operations
1867	Sample irradiation facility	Operations
1968	Sample irradiation facility	Operations
2568	Thermopile	Solid State
12 Fuel channels	Fission iodine production	Isotopes
Core hole	Shielding facility	Neutron Physics
Thermal column	Sample irradiation facility	Neutron Physics
East animal tunnel	Sample irradiation facility	Operations
West animal tunnel	Sample irradiation facility	Isotopes and Chemical Technology
Slant animal tunnel	Sample irradiation facility	Research

Filter House

On 10-19-59 the No. 1 filters in No. 3 cell were changed. They had been in service since 5-15-57. The filter media read 500 mr/hr at contact with a portable ionization chamber. Because of the high radiation and because of the poor mechanical condition of the frames it was decided to discard both the media and frames.

3. LOW-INTENSITY TEST REACTOR

3.1. Operations

W. R. Casto

Operations

The operating data for the LITR are given in Table 3.1.

TABLE 3.1. LITR OPERATIONS

Period October 1, 1959, through December 31, 1959

	This Quarter	Last Quarter	Year to Date
Total energy, Mwd	241.8	245.1	952.5
Average power, kw/operating hour	2,949	2,988	2,970
Time operating, %	89.1	89.2	87.8
Cooling water radioactivity, c/m/ml	37,125	44,500	44,100
Cooling water resistivity, ohm-cm	1,217,000	995,000	986,000
Fuel pieces charged	3	3	15*
Fuel pieces discharged	4**	2	15**
Shim rods charged	0	0	2
Shim rods discharged	0	0	2

*Includes 3 partial

**Includes 1 partial

Water System

The quality of the LITR cooling water increased this quarter. Table 3.1 shows that the specific resistance is higher and that the radioactivity is lower. Also, the average through-put per demineralizer run has increased from 1.5 million gallons to 3.2 million gallons. This improvement in operation can probably be attributed to the following.

1. A new stainless steel filter cartridge has been placed in service. In doing this the copper wire that was used as a core in the old, cotton twine unit was eliminated.
2. A different rinsing procedure for the cation section of the mixed-bed column was instituted.
3. After regeneration of the mixed-bed column, it is now put back in service with newly regenerated precolumns.

4. It is possible that a shim rod or a fuel element with a slight leak through the cladding was removed.

Operations Review

The Reactor Operations Review Committee recommended that the upper-limit switch of shim rod be lowered several inches in order to insure that the reactor would respond as quickly as feasible to a scram. These switches were moved down 1.8 inches. Any further changes in this direction will be difficult to obtain without considerable change in design.

The committee also specified that two of the three magnets have a release time of thirty milliseconds or less. Even this specification is proving difficult to meet with the present magnets.

Lattice Inventory

The lattice inventory is given in Table 3.2.

Lattice Change

Fuel was removed from lattice position C-18. The Naval Research Laboratory is now using this facility for radiation damage studies. In position C-21 the partial fuel element was replaced with a standard fuel element. These changes are shown in Figure 3.1.

Facility Employment

At the end of the year the LITR was being used as outlined in Table 3.3.

TABLE 3.2. LITR LATTICE INVENTORY AS OF DECEMBER 31, 1959

Position	Material	Weight (g)	Position	Material	Weight (g)	Position	Material	Weight (g)	Position	Material	Weight (g)	Position	Material	Weight (g)
51	F	126.995	41	Be		31	F (Fx)	88.147	21	F	196.424	11	F	133.254
52	Be		42	Be (SP)		32	F	173.605	22	F (SR)	107.265	12	F	175.768
53	Is		43	Al (SP)		33	F	131.861	23	F	187.827	13	F	150.648
54	Be		44	Be (SP)		34	F	133.145	24	F (SR)	94.975	14	F	173.787
55	F	150.779	45	F (Fx)	73.603	35	F	145.150	25	F	178.948	15	F	139.312
56	F	132.246	46	Be (SP)		36	F	135.980	26	F (SR)	80.262	16	F	153.525
57	Al (SP)		47	Be (SP)		37	F	196.878	27	F	174.025	17	F	139.161
58	Al (SP)		48	Al (SP)		38	F (Fx)	115.813	28	Be (SP)		18	Al (SP)	
59	F	134.763	49	Be		39	Is		29	Is		19	F	134.987

TOTAL: 3,959,115

Legend:

F - Fuel
Be - Beryllium
Fx - Partial Fuel Element
SR - Shim Rod
SP - Special Piece
Is - Isotope
Al - Aluminum

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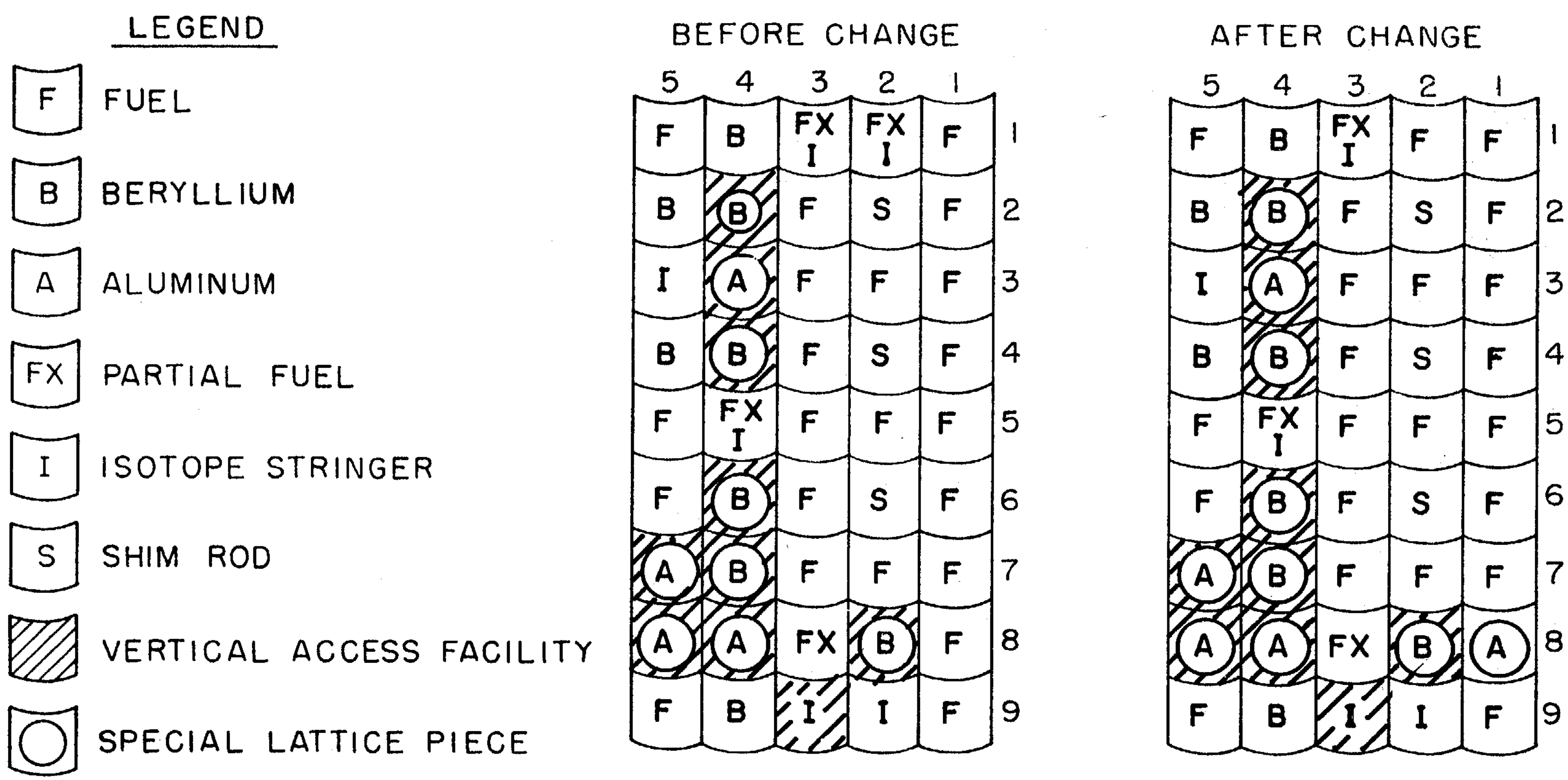

LITR LATTICE CONFIGURATION CHANGE

DATE OF CHANGE 12-15-59

FIGURE 3.1

TABLE 3.3 LITR FACILITY EMPLOYMENT

Facility	Nature of Experiment	Division Sponsor
C-28, C-42, C-44, C-46, C-47, C-57, and C-58	Fuel Test	Reactor Projects
C-48 and V-2	Fuel Test	Reactor Projects (GE)
C-18	Radiation Damage	Isotopes (NRL)
HB-1	Neutron Beam	Chemistry
C-43	Thorium Slurry	Chemical Technology
HB-2, HB-5, and HB-6	HRP Solutions	REED
C-38	Crystal Damage	Solid State
1/4 of C-39	Dry sample tube	Analytical Chemistry
3/4 of C-39	Isotopes	Isotopes
1/5 of P-tube	Pneumatic samples	Physics
3/4 of P-tube	Isotopes	Isotopes
C-29, C-31, C-45, C-53, and regulating rod facility	Isotopes	Isotopes
HB-3 and HB-4		Operations

4. LABORATORY FACILITIES

E. J. Witkowski

4.1. Radioactive Waste Disposal

White Oak Creek Discharge to Clinch River

The Health Physics monitoring data for radioactive waste discharged into the Clinch River during the last four quarters are listed in Table 4.1. A lower percent of the maximum permissible concentration was released during the last quarter in spite of two relatively high releases of activity. This drop was due to a decrease in Sr^{90} content of the waste, high river flows, and the absence of wash-out of silt from the former White Oak Lake bed.

TABLE 4.1. CLINCH RIVER MONITORING DATA

	% of MPC* in Clinch River	
	Average for Quarter	Highest Weekly Discharge
October 1 - December 31, 1959	11	42
July 1 - September 30, 1959	13	45
April 1 - June 30, 1959	44	159
January 1 - March 31, 1959	84	683

*The MPC in the Clinch River is the weighted average of the MPC values for occupational exposure of the individual radioisotopes as set forth by national and international committees on radiation protection. For prolonged exposure of a large population, it is recommended that the permissible levels be reduced by a factor of ten.

Process Waste

An equipment failure at the Hot Pilot Plant during the last week in October resulted in a release of activity into the system which was more serious than any single incident previously experienced. It is estimated that approximately 500 curies of mixed fission products were released into the system and that 65 curies were subsequently discharged into the creek. A much greater release was prevented only by special emergency procedures.

One of the shortcomings in the process waste system which became obvious was the lack of satisfactory monitoring equipment. It is now evident that the leak in the Pilot Plant equipment may have occurred on a small scale three days before it was detected, by which time it had become serious. Most of the activity was released after the Pilot Plant was found to be the source. During a period of one week, discharges continued because it was not possible to relate them to any particular operation or to determine with certainty the time of the occurrences. A complete monitoring system is being planned for process wastes so that in the future the source can be located more quickly.

Another serious weakness was found to be the small capacity of the Process Waste Treatment Plant and storage basin which prevented processing all wastes and made it impossible to recirculate the waste to obtain better decontamination. Even if the capacities were increased it does not appear that the plant could satisfactorily decontaminate highly contaminated waste. During this emergency, it was necessary to spray chemicals over the storage pond to reduce the activity handled by the Process Waste Treatment Plant. In order to handle high-level releases that may occur in the future, plans are being made to connect the storage basin, using an 8-in. pipeline, to a large lagoon in an area beyond the No. 4 burial ground and to pump process wastes there without treatment. Also included in the plans, is an expansion of the present settling basin to increase the storage capacity during an emergency by approximately 1,000,000 gallons.

Analytical data for the Process Waste Treatment Plant operation and the discharges to White Oak Creek are given in Table 4.2. The high level of the accidental release is reflected in the discharges shown for the month of November.

TABLE 4.2. PROCESS WASTE TREATMENT
AND DISCHARGE TO WHITE OAK CREEK

Volume of waste treated this quarter: 41,275,000 gal
Total volume of waste discharged this quarter: 62,099,000 gal

Contaminants	Process Waste Treatment Plant Influent			Process Waste Treatment* Plant Effluent			Total Discharge to* White Oak Creek	
	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.	Nov.	Dec.
	Activity Curies							
Sr^{89}	0.2	0.2	0.6	0.0	0.1	0.2	1.2	0.2
Sr^{90}	3.4	2.3	4.7	0.7	1.0	1.3	22.6	1.7
Ru^{106}	0.7	117.9	27.4	0.1	56.0	2.5	28.1	2.2
Co^{60}	0.2	1.0	3.3	0.1	0.8	1.5	1.0	2.0
Cs^{137}	3.4	65.9	82.7	0.4	14.1	11.7	16.2	20.5
TRE	7.3	349.2	75.7	1.3	67.7	2.4	49.4	4.8

*Prior to November 1959, the activity discharge into White Oak Creek was estimated from Gross Beta analyses. Analyses for individual radionuclides were begun in November to improve reporting accuracy. The total discharge of activity in the untreated waste during the month of October, estimated from Gross Beta analyses, was 4.26 curies.

Under normal operating conditions, the total activity discharged to the creek is the sum of that discharged from the Process Waste Treatment Plant and the activity contained in untreated waste. This was not true during this period, however, since the plant effluent containing a portion of the high release from the Hot Pilot Plant was transferred to the lagoons rather than to the creek.

High-Level Waste

A potentially serious break-through of Ru^{106} activity in the bank on the east side of waste pit No. 4 to White Oak Creek occurred during this period. It is estimated that between 300 and 350 curies of activity were released into the creek; this accounts for about one-fourth of the 11 percent of MPC shown in Table 4.1. Excavation of the area east of the pit revealed that the bulk of the release came through a narrow channel which flowed under the road into the swampy area east of the pit. The activity in the material released approached that contained in the pit itself; approximately 10^5 c/m/ml.

Plans are now being made to discontinue the use of the existing pits for future high-level wastes by replacing them with a covered soil column and another seepage pit in another location. For the interim period the condition has been corrected by intercepting the leakage and pumping it back into the pit.

The data for high-level waste pumped to the lagoons or pits are given in Table 4.3.

TABLE 4.3. HIGH-LEVEL WASTE TRANSFERRED TO WASTE PITS

	This Quarter	Total for 1959	Total for 1958
Volume, gallons	706,000	3,590,000	3,157,000
Activity, curies	78,000	280,000	52,800
Total activity to pits 2, 3, and 4 to date; curies	447,000		
Total volume to pits 2, 3, and 4 to date; gal	15,284,000		

Gas Disposal

A portion of the Laboratory area became contaminated on November 11 and 12 by a discharge from the 3039 stack. The contamination extended eastward through the Isotope area, the lawn north of Building 4500, and the east parking lot and in a northwest direction covering an area that included the south side of Building 3001, Building 3022, and extending as far as Building 2000. The contamination, totaling approximately 3 curies, was almost exclusively Ru^{106} which appeared to have fallen out in large particles, reading as high as 50 mr/hr, in some areas several feet apart and in other areas in isolated spots. It is believed that the material was dishcarged from the electrically driven, off-gas fan when the fan was turned on after a prolonged shutdown for repairs. The operation of the fan was resumed at about the same time the fallout occurred, and the composition of the fallout material was similar to that of the contamination found in the discharge side of the fan.

To prevent further discharges, all loose contamination was cleaned from the base of the stack and the cell-ventilation ducts between the fans and the stack. The off-gas blowers and all piping between the off-gas filters and the stack were also removed and decontaminated; the filters were replaced. The off-gas line and cell-ventilation duct between the Fission Product Pilot Plant-Metal Recovery area and the stack area were decontaminated.

As a result of this incident, a series of changes are planned in the gaseous waste system. The cell and hood-ventilation air has been discharged to the stack without filtering except at several high level processing areas. Even in these areas, however, the filters have sometimes failed so that a portion of activity by-passed the filters. In the case of the off-gas system prior to the incident, the filters could not be properly maintained because the chemical plant discharge plugged them in a short time. Furthermore, ruthenium passes through filters in a gaseous state; and a chemical scrubber has been found to be the only practical means of removing it.

Plans for improving the cell and hood-ventilation system include the installation of filters in all operating buildings and a secondary filter at the stack for all air prior to discharge. The new 4,000 cfm off-gas handling facility already under construction, will provide adequate scrubbing and filtering of all off gases. A complete monitoring system for the stack, cell ventilation, and off-gas systems is also being planned.

4.2. Manipulator Cell Operations

Dismantling Cells in Building 3026

Special equipment for the dismantling of the SRE fuel elements, the first phase of the PRFR mechanical operation, has been designed and is now being fabricated and installed in cell "A" and the storage cell. The equipment fabrication is approximately 85% complete with installation approximately 65% complete. February 15, 1960, is the present target date for the first "cold" run on dismantling the SRE fuel elements.

Cell B-2 has been used to dismantle a charcoal adsorber for the Reactor Chemistry Division and to dismantle capsules irradiated at the ORR, Graphite Reactor, and the LITR for Reactor Projects Division-GE. The same groups have requested continued use of cell B-2. The Reactor Chemistry Division has requested use of either cell B-1 or B-2 to segment experiment ORNL-41-2.

Planned alterations to the cells now in the design stage are: (1) increasing the capacity of the monorail system on top of the cells, (2) construction of a semihot storage area and maintenance cubicle over the cells, and (3) construction of a lead brick wall between cell B-1 and B-2.

ORR Cells

These cells are being operated for Solid States, and several Reactor Projects groups.

The north hot cell has been used for tests on irradiated specimens and post-irradiation examination of GCR-ORR experiments which was an extension of work started in the south hot cell. The south hot cell was operated for the disassembly of the eight GCR experiments irradiated at the ORR.

The addition of a semihot storage area south of the cells is scheduled to be completed by April 15, 1960. Fabrication and installation of a device to facilitate loading of the cells under water has been scheduled by the Engineering and Mechanical Division.

4.3. Liquid Hydrogen Dispensing Facility

Start-up of the facility has been delayed because of the malfunction of the relief valves on the hydrogen storage dewars during a cold run test with liquid nitrogen. New valves have been ordered with delivery promised by January 31, 1960.

One of the hydrogen dewars is presently being tested with liquid nitorgen. It is expected that the facility will be operated at 50% capacity within a few weeks.

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